ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT

OREGON

PROJECT TITLE: Evaluation of Habitat Improvements--John Day River

CONTRACT NUMBER: DE-AI79-83BP39801

PROJECT PERIOD: 1 October 1982 to 31 January 1984

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This project was funded by the Bonneville Power Administration.

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ABSTRACT

This report summarizes data collected in 1983 to evaluate habitat improvements in Deer, Camp, and Clear creeks, tributaries of the John Day River. The studies are designed to evaluate changes in abundance of spring chinook and summer steelhead due to habitat improvement projects and to contrast fishery benefits with costs of construction and maintenance of each project. Structure types being evaluated are: (1) log weirs, rock weirs, log deflectors, and in stream boulders in Deer Creek; (2) log weirs in Camp Creek; and (3) log weir-boulder combinations and introduced spawning gravel in Clear Creek.

Abundance of juvenile steelhead ranged from 16% to 119% higher in the improved (treatment) area than in the unimproved (control) area of Deer Creek. However, abundance of steelhead in Camp Creek was not significantly different between treatment and control areas. Chinook and steelhead abundance in Clear Creek was 50% and 25% lower, respectively in 1983, than the mean abundance estimated in three previous years.

The age structure of steelhead was similar between treatment and control areas in Deer and Clear creeks. The treatment area in Camp Creek, however, had a higher percentage of age 2 and older steelhead than the control. Steelhead redd counts in Camp Creek were 36% lower in 1983 than the previous five year average. Steelhead redd counts in Deer Creek were not made in 1983 because of high streamflows. Chinook redds counted in Clear Creek were 64% lower than the five year average. Surface area, volume, cover, and spawning gravel were the same or higher than the corresponding control in each stream except in Deer Creek where there was less available cover and spawning gravel in sections with rock weirs and in those with log deflectors, respectively. Pool:riffle ratios ranged from 57:43 in sections in upper Clear Creek with log weirs to 9:91 in sections in Deer Creek with rock weirs.

Smolt production following habitat improvements is estimated for each stream. Preliminary cost estimates are summarized for each habitat project and economic benefits are calculated for Deer Creek.

Introduction

The Oregon Department of Fish and Wildlife (ODFW) began a study in 1983 to evaluate habitat improvement projects in Deer Creek, a tributary of the South Fork of the John Day River at km 45; Camp Creek, a tributary of the Middle Fork of the John Day River at km 77; and Clear Creek, a tributary of Granite Creek, which flows into the North Fork of the John Day River at km 141 (Fig. 1). Only the habitat project on lands administered by the Bureau of Land Management was evaluated in Deer Creek in 1983. All three studies are designed to measure changes in abundance of spring chinook or summer steelhead due to habitat improvements and to contrast fishery benefits with costs of design, construction and maintenance.

We completed the first year of the five year evaluation in Deer and Camp creeks in 1983. These two studies began the first year following the completion of habitat improvements in each stream. In Clear Creek, 3 years of data on fish abundance had already been collected prior to sampling in 1983. Tasks from the 1982-83 work statement to the Bonneville Power Administration

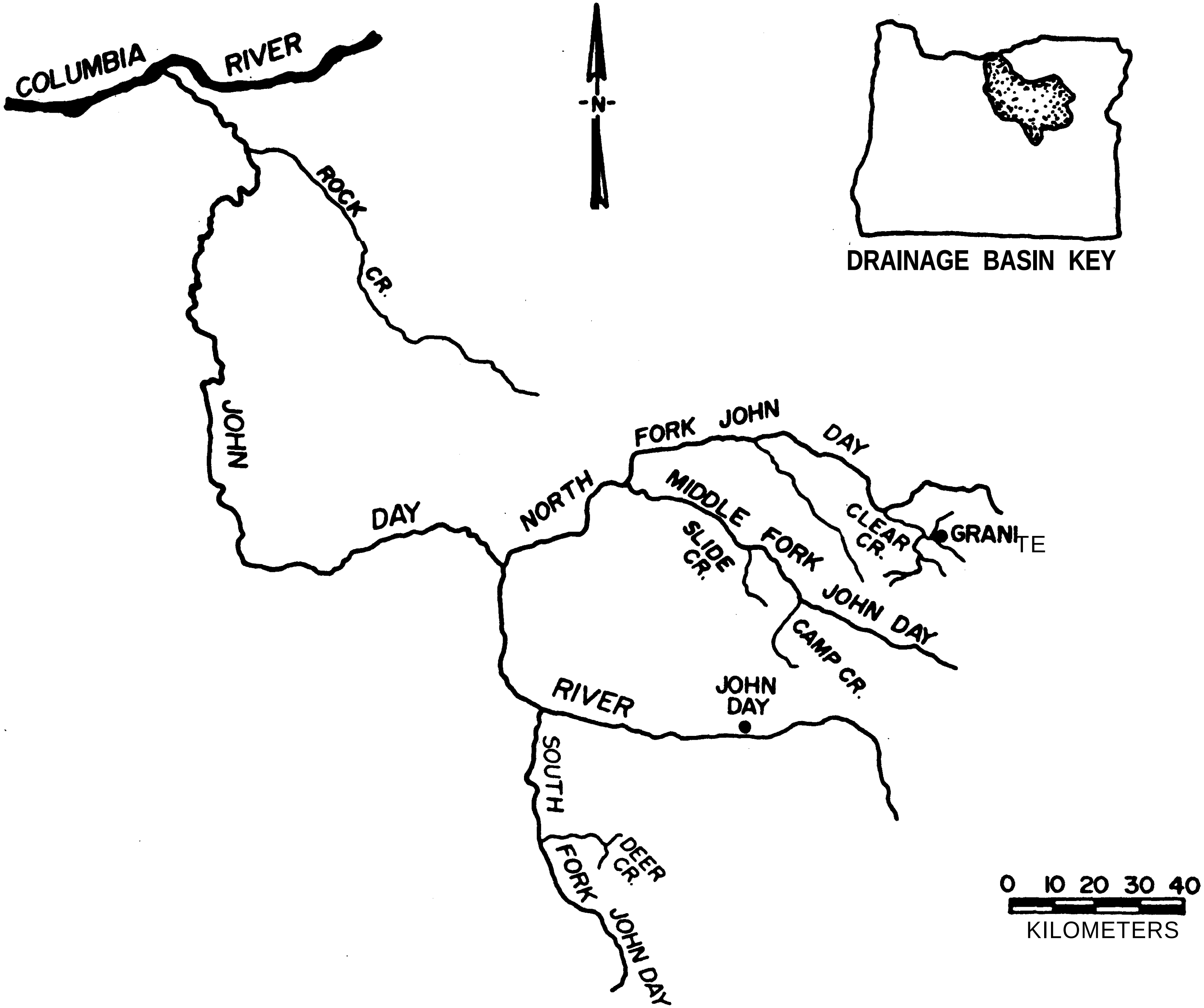

Fig. 1 Location of study areas in the John Day basin.

(BPA) are addressed in this report. These tasks are:

Deer Creek

1. Estimate densities and age/size structure of age 1 and older juvenile steelhead in treatment and control areas.

2. Conduct spawning ground redd counts of adult summer steelhead.

3. Document changes in surface area, stream depth, and spawning gravel due to habitat improvements. Establish photo-points to monitor changes in structures and in the stream channel. Pool:riffle ratios and cover area were not specified in the workstatement to BPA but were measured as part of this task.

4. Estimate steelhead smolt production due to habitat improvements.

5. Calculate the benefit/cost of the habitat project.

Camp Creek

1. Estimate densities of juvenile spring chinook and steelhead and age/size structure of age 1 and older juvenile steelhead in treatment and control areas. Collect weights from a random sample of age 0 and older juvenile steelhead.

2. Conduct spawning ground redd counts of adult summer steelhead and document use of spawning gravel collected by weirs or other structures placed in Camp Creek as part of the improvement project.

3. Document changes in surface areas, stream depth, and pool:riffle ratios. Establish photo-points to monitor changes in structures and 'in the stream channel. Cover and spawning gravel were not specified in the work statement to BPA but were measured as part of this task.

4. Estimate chinook and steelhead smolt production due to habitat improvement.

5. Calculate the benefit/cost of the habitat project.

Clear Creek

1. Estimate densities of juvenile spring chinook and steelhead before and after habitat improvement. Document the use of constructed holding pools by adult chinook.

2. Conduct spawning ground counts of adult spring chinook in upper and lower Clear Creek and document the use of introduced spawning gravels.

3. Document changes in surface area and available spawning gravel in upper and lower Clear Creek. Parameters not specified by the workstatement but measured as part of this task are stream depth, pool:riffle ratio, and cover area.

4. Estimate chinook and steelhead smolt production resulting from habitat improvement.

5. Calculate the benefit/cost of the habitat project.

Additional background information on the improvement projects and the overall goal and objectives of these three evaluations is in the 1982-83 work statement to BPA.

DEER CREEK

Methods

Task 1

Juvenile steelhead[1] were sampled in late July at stations located in improved (treatment) and unimproved (control) areas of Deer Creek (Fig. 2). The treated area contained the following structures: (1) log weirs, (2) rock weirs, (3) log deflectors, and (4) instream boulders. Because the four structure types were interspersed within the project area, the boundaries of each sampling station were established at points above and below an individual structure where the physical character of the stream was no longer influenced by the structure. Areas influenced by adjacent structures of different types were not included as sampling stations. Twenty-five sampling stations, ranging from 9 m to 50 m in length, were established in the project area. Boundaries were marked with numbered metal stakes.

Six control stations, approximately 50 m in length, were established in Deer Creek above the uppermost habitat structure. Control stations were selected in areas which were similar in substrate, gradient, depth, and cover to the treatment area prior to habitat improvement. Boundaries of each station were marked with numbered metal stakes at natural breaks such as riffles or the head of pools.

Population estimates of juvenile steelhead were made with either the two or three pass removal method (Zippin 1958; Seber and Whale 1970). Boundaries of each sampling station were blocked with seines prior to sampling and two or three electrofishing units, working simultaneously, were used to collect fish. Shocking began at the upper blocking seine and continued downstream to the lower blocking seine. Catch was recorded separately for each pass. Two passes were initially made through each sampling station. After the second pass, a population estimate was calculated. If confidence limits of the two pass estimate exceeded plus or minus 25% of the point estimate, then a third pass was made and abundance was estimated with the three pass removal method. No estimates of age 0 steelhead were made because emergence was not complete at the time we sampled Deer Creek.

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1 Resident rainbow trout are thought to be present in each study stream; however, because there is no way to distinguish juvenile trout from juvenile steelhead, we have lumped the two together and referred to them as steelhead.

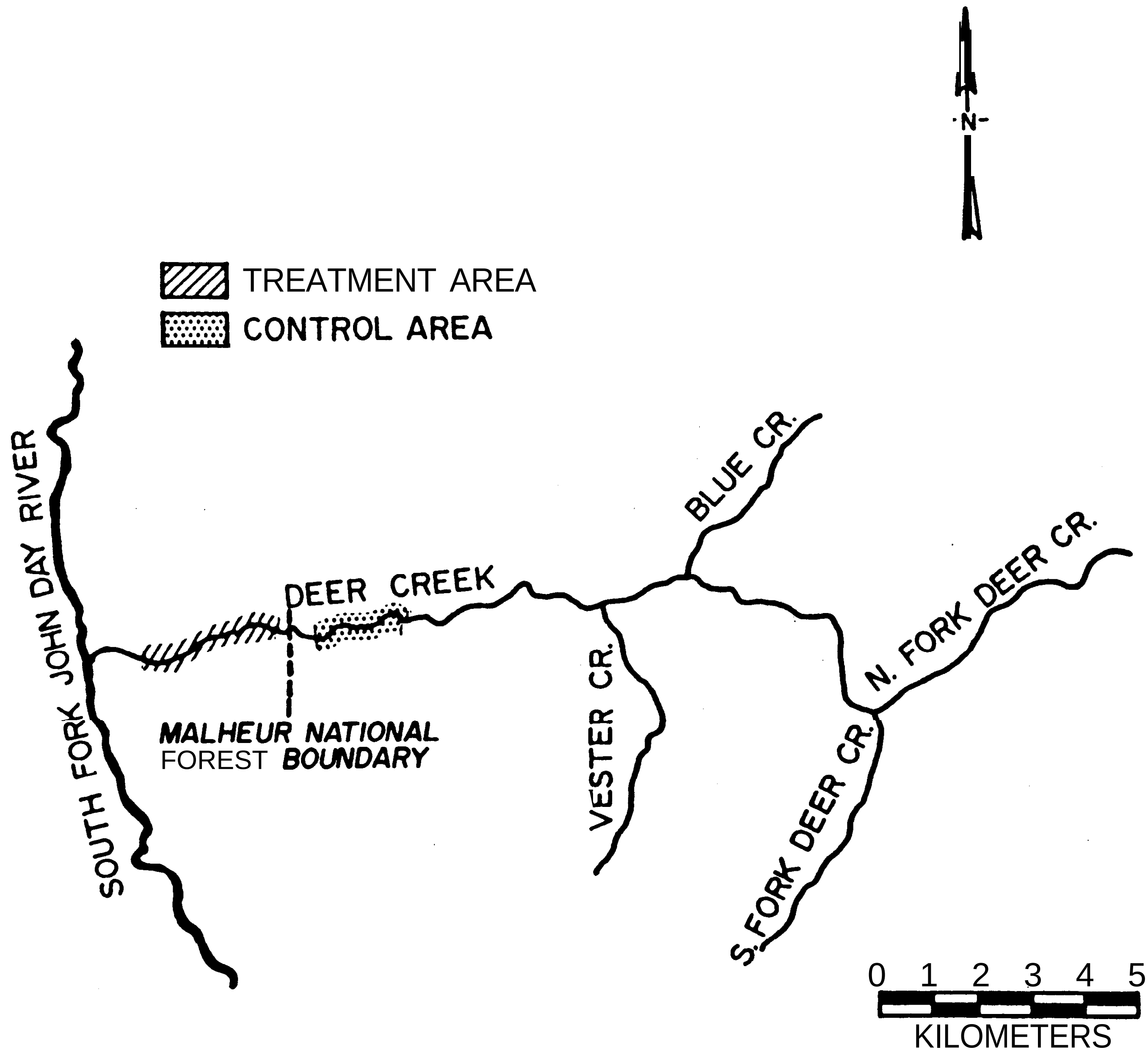

Fig. 2 Location of sampling areas in Deer Creek.

All steelhead age 0 and older were measured to the nearest 1.0 mm, fork length. A random sample of scales was collected to determine age structure and size range of each age class in the study area. Scales were collected from the area above the lateral line just behind an imaginary line extending perpendicular from the lateral line to the distal point of attachment of the dorsal fin. Scales were transferred to numbered gummed cards.

Scales were aged from plastic acetate impressions of the gummed cards. Impressions were made by compressing (6,000 psi) both a gummed card and a plastic sheet between two heated (220°F) metal plates for 3 minutes. The plastic sheets were inserted into a microfiche reader which magnified and projected the scale images on a screen. Magnification was set at 86.1 power. Steelhead were aged by counting the number of annuli.

Task 2

Spawning grounds were surveyed to obtain an index of the number of adult steelhead that spawned in Deer Creek. Surveys were conducted in the historical index area established by the ODFW. The index area extends 9.7 km from the Malheur National Forest boundary to the mouth of Blue Creek (Fig. 2).

Task 3

We measured stream depth, stream width, station length, pool:riffle ratio, spawning gravel area, and cover with a tape or meter stick to document physical changes as a result of habitat improvements. Surface area and volume of water were calculated from depth, width and length measurements. Sampling was conducted between 12 July and 26 July in Deer Creek.

Stream widths were measured at ten evenly-spaced intervals within each sampling station that was more than 31 m in length. At sampling stations shorter than 31 m in length, three to ten widths were measured at evenly spaced intervals depending on the length of the station.

Stream depths were measured at four evenly spaced intervals along each width measurement. Depth was recorded at intervals of one-eighth, three-eighths, five-eighths, and seven-eighths of the stream width.

Areas of low velocity covering two-thirds of the stream width were subjectively classed as pools. Pool length was the sum of the lengths of each individual pool in a given sampling station. Lengths were measured along the thalweg. Areas not classed as pools were considered riffles.

Spawning gravel area was estimated in each sampling station by measuring the surface area of gravel that was suitable for spawning. Suitable areas were those in which the gravel was approximately 1 cm to 8 cm in diameter and not compacted and in which water depth and velocity appeared suitable for spawning. Areas of gravel less than approximately 0.1 m2 were not included. Estimates of spawning gravels made in summer may be minimal because streamflows are lower than would occur during spawning in spring.

Cover within each sampling station was classified as bank, riparian, boulder, turbulence, or weir types. The area of each cover type was estimated by measuring the water surface which we subjectively determined was influenced by that cover type. Boulders less than 40 cm in diameter were not included as boulder cover.

Photo-prints were established at selected sites to graphically document changes in the stream because of habitat improvements. Stakes that marked the boundaries of sampling stations were also used to mark photopoints.

Task 4

The approach to this task in 1983 was to apply a survival rate from juvenile to smolt to the actual abundance estimates of juvenile steelhead made in summer 1983 to obtain a prediction of the number of smolts produced in spring 1984. A survival rate was obtained from the literature. Juvenile abundance in control areas were used to establish pre-project population levels and were subtracted from the abundance estimated after improvements were completed to give net change in abundance. The specific steps of this approach are tabled in the results section under Task 4 for Deer Creek

Task 5

Preliminary estimates of benefits and costs of the habitat improvements in Deer Creek were calculated to illustrate a general approach that could be used to obtain benefit/cost ratios. Actual benefits cannot be determined adequately after only one year.

Benefits were based on the net gain in smolts calculated in Task 4. Smolt to adult survival rates and exploitation rates from the literature were applied to smolts and adults, respectively, to obtain estimates of catch and escapement. Economic values of the adults also came from the literature. The specific steps of this approach are tabled in the result section under Task 5. Preliminary cost estimates for habitat improvement were obtained from the Bureau of Land Management, Burns District.

Results

Task 1

Mean densities of age 1 and older steelhead ranged from 16% to 119% higher in the improved area of Deer Creek than in the unimproved area in 1983 (Table 1). Age structure between treatment and control areas was generally similar although there was a tendency for stations with boulders to contain a higher percentage of age 2 and older steelhead than did the other stations (Tables 2 and 3). Overall, mean lengths of age 1 and older steelhead were similar between treatment and control areas (Table 4).

Task 2

Redd counts for steelhead could not be made in 1983 because of high streamflows during spawning. Counts for the,previous 5 years are shown in Table 5.

Table 1. Abundance of age 1 and older steelhead associated with each of four habitat improvement structures on Deer Creek, 1983.

Structure	No./100 m	95% CL
Log weirs	244	199-303
Rock weirs	149	90-208
Log deflectors	176	128-224
Instream	280	194-366
Control	128	111-145

Table 2. Mean lengths, by age class, of age 1 and older steelhead in Deer Creek, 1983.

Structure	Age	Sample size	Fork length (mm) Range	Mean	95% CI
Log weirs	1	108	63-136	88	+3
	2	24	95-132	115	+4
	3	3	103-155	135	+69
Rock weirs	1	30	72-123	88	+4
	2	7	103-132	115	+11
	3	1	156	--	--
Log deflectors	1	23	66-119	85	+5
	2	7	108-142	125	+12
	3	1	150	--	--
Boulders	1	26	68-125	90	+6
	2	11	102-139	119	+9
	3	3	153-197	171	+58
Control	1	68	66-116	89	+3
	2	20	94-139	116	+6
	3	2	123-144	--	--

Table 3. Age composition (percentage) of age 1 and older steelhead in Deer Creek, 1983.

Structure	Age 1	Age 2	Age 3
Log weirs	80	18	2
Rock weirs	79	18	3
Log deflectors	74	23	3
Boulders	65	28	8
Control	76	22	2

Table 4. Mean lengths of age 1 and older steelhead in Deer Creek, 1983.

Structure	Sample size	Fork length (mm)		
		Range	Mean	95% CL
Log weirs	486	63-225	88	+2
Rock weirs	260	63-203	88	+3
Log deflectors	171	63-199	91	+4
Boulders	157	63-197	88	+4
Control	373	63-173	85	+2

Table 5. Steelhead spawning ground counts in Deer Creek, 1978-83.

Year	Redds/mile
1978	3.8
1979	0.5
1980	2.8
1981	4.5
1982	6.9
1983	[a]

a No survey because of high, turbid streamflows during spawning.

Task 3

Physical characteristics of control stations were used to establish pre-project conditions and were compared with characteristics of treatment stations. Surface area, volume, pool:riffle ratio, cover area, and spawning gravel area were higher in improved than in unimproved areas except that stations with rock weirs had lower pool:riffle ratios and less cover than did the controls (Table 6). Stations with log deflectors also contained less spawning gravel than did the control (Table 6). A comparison between pre-project and post-project conditions expanded for the entire project area is given in Table 7. Data from habitat inventories of the U.S. Forest Service, Malheur National Forest will be examined in 1984 to determine if they can also be used to document pre-project conditions in Deer Creek.

Task 4

Preliminary estimates of steelhead smolt production due to habitat improvements were made in 1983. Based on juvenile to smolt survival rates determined by Everest and Sedell (1982) Smolt output increased by 1,347 fish due to improvements (Table 8). This is 7% higher than the 1,254 smolts originally predicted for the project (Wiley 1982). Estimates of the percentage of each age class of steelhead present in summer which migrate the following spring as smolts will be available from the Camp Creek study in 1984. These data should improve the accuracy of our smolt estimates in Deer Creek.

Table 6. Physical characteristics associated with each of four different habitat improvement structures in Deer Creek, 1983.

Structures	Surface area (m2/100 m)	(m3/100 m)	Pool: riffle ratio	Cover (m2/100 m)	Spawning gravel (m^2/100 m)
Log weirs	575	145	45:55	42	73
Rock weirs	582	79	9:91	11	102
Log deflectors	578	104	44:56	27	54
Boulders	560	120	35:65	25	104
Control	480	79	15:85	21	69

Table 7. Physical characteristics expanded for the entire project area of Deer Creek before and after habitat improvements.

Characteristic	Pre-project[a]	Post-Project
Length (km)	3.2	3.2
Surface area (m2)	15,360	18,360
Volume (m3)	2,528	3,584
Spawning gravel (m2)	2,208	2,664
Cover (m2)	672	840
Pool: riffle ratio	15:85	33:67

a Pre-project conditions were based on those measured in the control area of Deer Creek.

Table 8. Calculation of net change in abundance of steelhead smolts on Deer Creek after habitat improvement based on data collected in 1983.

Length of project (km)	3.2
Pre-project[a]	
Juveniles/km	1,280
Total juveniles	4,096
Post-project	
Juveniles/km	2,122
Total juveniles	6,790
Net change of juveniles	+ 2,694
Survival, juvenile to smolt	0.50[b]
Net change in smolts	+ 1,347

a Estimates based on the control section in Deer Creek.

b From Everest and Sedell (1984)

Task 5

Economic benefits based on only one year of data, especially the first year following construction of habitat improvements, is tenuous at best. However, to provide an example of the general approach that might be used to estimate adult production and benefits, we have summarized the basic steps in Table 9. Preliminary cost estimates for construction and maintenance of habitat improvements on Deer Creek are summarized on Table 10.

The benefit/cost ratio discounted 7% over a 20 year life expectance would be approximately 4.19 for the Deer Creek project based on data collected in 1983. These calculations are shown merely to illustrate what we think, at this point, will be our approach to Task 5. More realistic assessments of fish production and, subsequently, economic benefit will be available at the completion of our evaluations.

Table 9. Preliminary estimates of adult production and economic benefits from habitat improvements in Deer Creek based on data collected in 1983.

Increase in smolts from improvements (Table 8)	1,347
Smolt to adult survival	0.032'1
Exploitation rate	0.30 b
Increase in sport harvest	13
Increase in spawner escapement	30
Benefit (present-worth, discount rate @ 7%)	$130,845[c]

a Based on a 4% smolt to adult mean survival rate for summer steelhead at Round Butte Hatchery on the Deschutes River adjusted downward by 20% for additional smolt mortality at John Day Dam.

b Rate from Lindsay et al. (1981) for the Deschutes River.

c Values used were $214 for each sport caught fish and $359 for each spawner (Meyer 1982) over a 20 year life expectancy of the improvements. Calculation of present-worth was by methods of Everest and Talhelm (1982).

Table 10. Preliminary cost estimates of habitat improvements in Deer Creek.

Construction total[a]		$ 22,760
10	Fog weirs @ $1,210 ea	12,100
3	Rock weirs @ 323 ea	969
4	Log deflectors (double) @ 1,060 ea	4,240
3	Log deflectors (single) @ 529 ea	1,587
2	Log cut-bank protectors @ 432 ea	864
100	Boulders @ $30 ea	3,000
Maintenance (annual)a		$ 800
Total cost (present-worth, discounted @ 7%)		$ 31,232

a Personal communication, Ron Wiley, Burns District BLM.

b Estimates of present-worth were by methods of Everest and Talhelm (1982) over a 20 year life expectancy of the project.

CAMP CREEK

Methods

Task 1

Juvenile steelhead were sampled between 1 August and 12 August in treatement and control stations in Camp Creek. Sampling areas were established by dividing the stream into segments in which log weirs were present (i.e. treatments) and segments in which log weirs were not present (i.e. controls (Fig. 3). The treatment and control segments were dispersed throughout the length of the stream up to km 12.4. In addition to the control segments located within the project boundaries, a 1 km segment of stream above the upper boundary was included as a control.

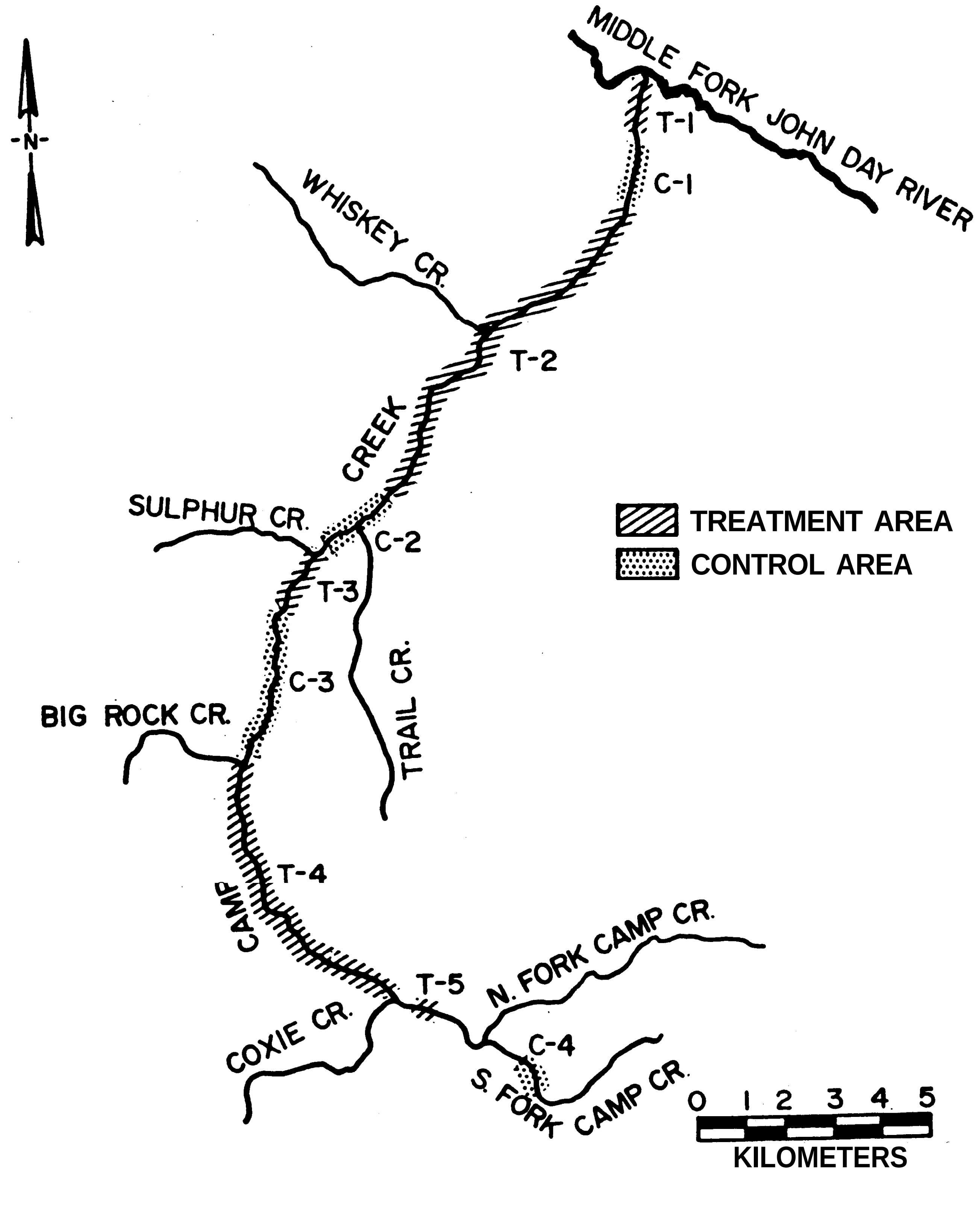

Fig. 3 Location of sampling areas in camp Creek.

Sixteen sampling stations, approximately 50 m in length, were established in each of the treatment and control areas (Table 11). Stations were selected systematically to insure coverage of the stream. The boundaries of each sampling station were natural breaks such as the head of riffles whenever possible.

Table 11. Distribution of sampling stations in treatment and control areas in Camp Creek.

Stream segments (shown in Fig. 3)	Sampling stations
Treatment	
T-l	1
T-Z	2-8
T-3	9
T-5	10-15
	16
Control	
C-l	l-3
c-2	4-6
c-3	7-14
c-4	15-16

Six sampling stations, ranging from 32 m to 73 m in length, were also established as controls in Slide Creek (Fig. 4), a tributary of the Middle Fork and adjacent to Camp Creek. Sampling stations in this stream will be used as external controls to determine if control stations in Camp Creek are independent of treatment stations in spite of their close proximity to one another. Stations in Slide Creek were selected to duplicate as closely as possible the substrate, depth, and cover of control areas in Camp Creek. Flows, however, are generally less in Slide Creek during the summer sampling period.

Densities of juvenile steelhead and spring chinook were estimated by methods given in Task 1 for Deer Creek. No estimate of age 0 steelhead was made because emergence was not complete at the time we sampled Camp Creek.

Lengths and scales were collected from all age 1 and older steelhead and from a random sample of age 0 steelhead. Lengths and scales were collected and scales aged by methods given in Task 1 for Deer Creek. Lengths were measured from all age 0 chinook to the nearest 1.0 mm, fork length. Weights were not recorded in 1983.

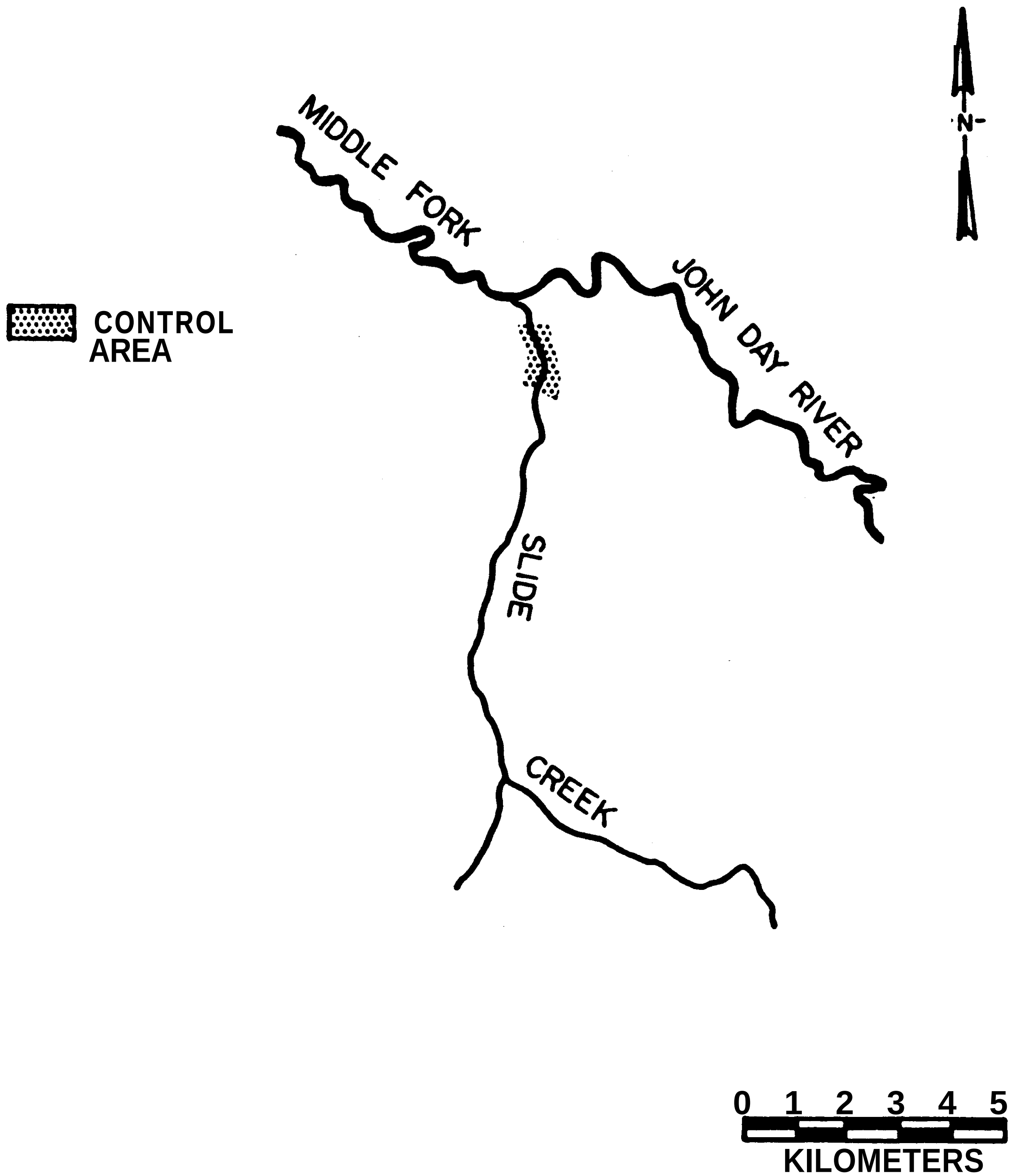

Fig. 4 Location of sampling areas in Slide Creek.

Task 2

Spawning grounds were surveyed to obtain an index of the number of adult steelhead that spawned in Camp Creek. Surveys were conducted in historical index areas established by the ODFW. The index area extends 10.5 km from the mouth of Sulphur Creek to the mouth of the North Fork of Camp Creek (Fig. 3). Because little time had elapsed between the time structures were installed in Camp Creek in 1982 and the time of spawning in 1983, use of gravels collected by the habitat structures was not documented in 1983.

Task 3

Methods for measuring stream depth, stream width, station length, pool:riffle ratio, spawning gravel, and cover are described in Task 3 for Deer Creek. Sampling was conducted in Camp Creek between 1 August and 12 August. Photo points were established by methods described in Task 3 for Deer Creek.

Task 4

Methods of calculating smolt production from habitat improvements in Camp Creek were the same as those described for Deer Creek. Better estimates of smolt production should be available in 1984 because the number of smolts actually migrating from Camp Creek will be estimated in spring 1984 by using Humphrey scoop and inclined plane traps below the project area.

Task 5

Benefits were not calculated for Camp Creek based on 1983 data because there was no difference in juvenile abundance between improved and unimproved areas. Preliminary cost estimates for the improvements were obtained from the USFS, Malheur National Forest.

Results

Task 1

The mean density of juvenile steelhead in improved areas of Camp Creek was virtually the same as that in unimproved areas in 1983, the first year following completion of improvements in that stream (Table 12). Overall, the mean length of steelhead tended to be larger in treatment areas than in control areas (Table 13) on Camp Creek. This was due to more age 2 fish and fewer age 1 fish on the treated areas than in the controls (Tables 14 and 15) rather than to any differences in growth between areas. It should be pointed out that age 1 and older steelhead in all the study streams emerged prior to the time habitat imrovement structures were installed and may have been effected by the construction. Sampling stations on Camp Creek will be re-examined in 1984 in conjunction with biologists from the USFS, Malheur National Forest and the ODFW to make certain that control stations are representative of conditions that existed prior to improvements and that treatment stations are representative of improved areas.

Table 12. Abundance of age 1 and older steelhead and age 0 chinook in Camp and Slide creeks, 1983.

Location	Number/100m Steelhead (95% Ch)	Chinook (95% Ch)
Camp Creek		
Treatment	124 (102-146)	a
Control	129 (109-149)	0
Slide Creek (Control)	57 (25-89)	0

a Only 1 chinook was captured in Camp Creek in 1983.

Table 13. Mean lengths of age 1 and older steelhead in Camp and Slide creeks, 1983.

Location	Sample size	Fork length (mm)		
		Range	Mean	95% CI
Camp Creek				
Treatment	946	72-236	108	+2
Control	1,016	72-208	104	+1
Slide Creek				
Control	181	80-178	110	+3

Table 14. Mean lengths, by age class, of age 1 and older steelhead in Camp and Slide creeks, 1983.

Location	Age	Sample size	Fork length (mm)		
			Range	Mean	95% CI
Camp Creek					
Treatment	1	249	72-139	99	+2
	2	49	113-182	143	+5
	3	5	167-200	188	+15
	4	1	212	--	--
Control	1	342	76-149	98	± 1
	2	38	117-166	139	+3
	3	5	159-183	173	+12
	4	2	183-191	--	--
Slide Creek					
(Control)	1	75	80-166	109	+4
	2	5	133-155	141	+12
	3	2	170-178		--

Table 15. Age composition (percentage) of age 1 and older steelhead in Camp and Slide creeks, 1983.

Location	Age 1	2	3	4
Camp Creek				
Treatment	82	16	2	0.3
Control	88	10	1	0.5
Slide Creek (Control)	91	6	2	0

Task 2

Steelhead redd counts in Camp Creek were 36% lower in 1983 than the previous 5-year average (Table 16); however, the previous average was weighted heavily by a high count in 1978. The 1983 brood will be the first to have emerged in Camp Creek after improvements were completed.

Task 3

Physical characteristics in the control sections were used to establish pre-project conditions and compared to those same characteristics after habitat structures were placed in Camp Creek. Surface area, volume, pool:riffle ratios and cover area were higher in improved areas than in the controls while the amount of spawning gravel was the same (Table 17). A comparison of pre-project and post-project conditions expanded for the length of the project area is given in Table 18. Data from habitat inventories of the USFS, Malheur National Forest will be examined in 1984 to determine if they can also be used to document pre-project conditions in Camp Creek.

Table 16. Steelhead spawning ground counts in Camp Creek, 1978-83.

Year	Redds/mile
1978	12.0
1979	1.5
1980	3.8
1981	a
1982	a
1983	4.2

a No survey due to high, turbid streamflows,

Table 17. Physical characteristics of improved (treatment) and unimproved (control) areas in Camp Creek and in the control area in Slide Creek.

Location	Surface area (m2/100 m)	Volume (m3/100 m)	Pool: riffle ratio	Cover (m2/100 m)	Spawning gravel (m2/100 m)
Camp Creek					
Treatment	529	68	30:70	11	2
Control	501	51	22:78	7	2
Slide Creek					
Control	396	39	19:81	3	0.2

Table 18. Physical characteristics expanded for the entire project area in Camp Creek before and after habitat improvement.

Characteristic	Pre-project[a]	Post-project
Length (km)	12.4	12.4
Surf ace area (m2)	62,124	65,596
Volume (m3)	6,324	8,432
Spawning gravel (m2)	248	248
Cover (m2)	868	1,364
fool: riffle ratio	22:78	30:70

a Pre-project conditions were based on those measured in control areas of Camp Creek.

Task 4

Actual estimates of the number of smolts migrating from the project area in Camp Creek will be made in spring 1984. Estimates will be pro-rated to treatment and control areas based on abundance (or biomass) by age class present the previous summer. Because no smolt estimate has yet been made in Camp Creek, we used survival rates from Everest and Sedell (1984) to calculate smolt output from juvenile abundances estimated in summer 1983 (Table 19). Although the calculations show a decrease in smolt production after improvements, the precision of our juvenile estimates are such that statistically, there was no difference in steelhead abundance between treatment and control areas in 1983.

Task 5

Benefits were not estimated because there was no difference in juvenile abundance between treatment and control areas in 1983 in Camp Creek. The general approach for estimating benefits is given in Task 5 in the results section for Deer Creek. Costs associated with the habitat improvement project on Camp Creek are summarized in Table 20.

Table 19. Calculation of net change in abundance of steelhead smotls in Camp Creek following habitat improvement based on data collected in 1983.

Length of project (km)	12.4
Pre-project[a]	
Juveniles/km	1,290
Total juveniles	15,995
Post-project	
Juveniles/km	1,240
Total juveniles	15,376
Net change of juveniles	-619
Survival, juvenile to smolt	0.50[b]
Net change in smolts	-310

a Estimates based on the control section in Camp Creek.

b From Everest and Sedell (1984)

Table 20. Preliminary cost estimates of habitat improvements in Camp Creek.

Construction		
128	Log weirs (BPA funds)	$ 70,000
155	Log weirs (USFS funds)	83,000
	Fencing and seed	6,000
	Total	$159,000
Maintenance (annual)		$ 3,000
Total cost (present-worth, discounted @ 7%)		$190,770

a Estimates of present-worth were by methods of Everest and Talhelm (1982) over a 20 year life expectancy of the project.

CLEAR CREEK

Methods

Task 1

The evaluation of habitat improvements in Clear Creek differs in approach from those in Deer and Camp creeks in that data on fish abundance were collected prior to habitat improvement (i.e. pre-treatment) in the stream. Burck et al. 1979 and 1980 describes the Clear Creek study area and give additional background information for this study.

Chinook and steelhead were sampled at stations in two treatment areas in Clear Creek and in control areas in Granite and Bull Run creeks (Fig. 5). Twenty-four sampling stations, ranging from 37 m to 73 m in length, were established in the study area. Twelve sampling stations were established in Clear Creek in as close as possible to the same locations as the original twelve stations in which pre-treatment data were collected from 1979 through 1981. Of the twelve stations in Clear Creek, six are in upper Clear Creek and six are in lower Clear Creek. Each of the six stations in upper Clear Creek are bounded by weirs and each include one to two weirs. Each station is separated by at least one weir. Instream boulders were not placed in these stations. Each of the six sampling stations in lower Clear Creek contained one weir with the boundaries of each station at natural riffle breaks above and below the weir. Three of the sampling stations include boulders.

Six control stations were systematically selected in each of Granite and Bull Run creeks in areas similar in gradient and substrate to Clear Creek prior to habitat changes. Natural breaks were used as station boundaries. Numbered metal stakes were used to mark boundaries of the stations.

Abundance of juvenile spring chinook and steelhead were estimated by methods given in Task 1 for Deer Creek. No estimate of age 0 steelhead was made because emergence was not complete at the time we sampled.

Lengths and scales from steelhead were collected and scales aged by methods outlined in Task 1 for Deer Creek. A random sample of 40-50 chinook were measured to the nearest 1.0 mm, fork length, in each of the four study areas. Adult chinook were counted in pools constructed for holding adults in Clear Creek in summer.

Task 2

Spawning grounds were surveyed to obtain an index of the number of chinook salmon spawning in Clear Creek and to document use of spawning gravel introduced in Clear Creek as part of the improvement project. Historical index

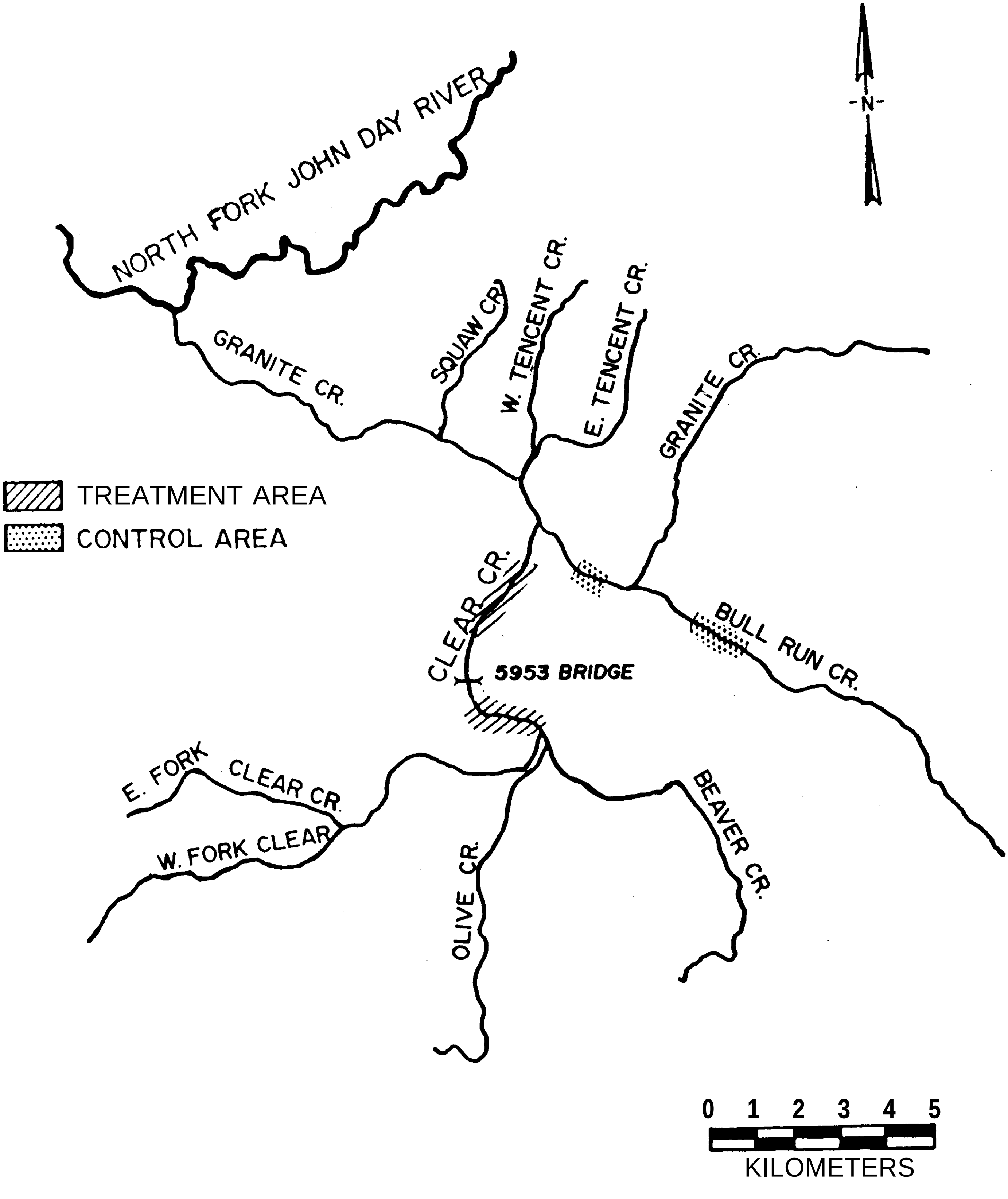

Fig. 5 Location of sampling areas in Clear Creek.

surveys are located on Clear Creek, Granite Creek, and Bull Run Creek (Lindsay et al. 1981). An additional survey section was established in upper Clear Creek from S955 bridge to the mouth of Beaver Creek.

Surveys were conducted by one person walking downstream from the upper to the lower boundary of a survey section. Live fish, dead fish, and redds were counted. 'Live fish were recorded as jacks or adults. Use of introduced spawning gravel was noted in Clear Creek. Data were recorded relative to established geographical checkpoints within each survey section. The surveys were conducted on 12 September. Steelhead redd counts are not made in mainstem Clear Creek but are made in tributaries, Beaver and Olive creeks (Fig 5).

Task 3

Methods for measuring stream depth, stream width, station length, pool:riffle ratio, spawning gravel area, and cover area are described in Task 3 for Deer Creek. Sampling was conducted between 15 August and 19 August.

Task 4

Tne approach to estimating smolt production in Clear Creek differed from that in Deer and Camp creeks because pre-treatment data had been collected prior to 1983 by the ODFW (Burck et al. 1979 and 1980). The difference between pre-project juvenile abundance and post-project abundance was used to determine the net change in juvenile population levels due to habitat improvement. Survival rates from juvenile to smolt were obtained from the literature. Specific steps of this approach are tabled in the results section under Task4 for Clear Creek.

Task 5

Benefits were not calculated from data collected in Clear Creek in 1983 because no increase in juvenile abundance was observed. Originally we had thought that 1983 would be the first post-treatment year for assessing change due to habitat improvements in Clear Creek. However, because of continued instream improvement work coupled with a sudden large discharge of mining effluents from a settling pond blowout, it appears that 1983 cannot be considered a post-treatment data point. Preliminary cost estimates of the habitat improvements were obtained from the USFS, Umatilla National Forest.

Results

Task 1

The mean density of juvenile spring chinook increased from a previous 3 year high of 3 fish/l00m to 16 fish/100m in upper Clear Creek in 1983 (Table 21). However, in lower Clear Creek, chinook abundance in 1983 was 59% lower than the previous 3 year average in spite of a high number of spawners in 1982. Although the control of Granite Creek showed a 31% decrease in 1983 (Table 22), we suspect the additional decline in abundance in lower Clear Creek may be attributed to a sudden discharge of mining effluents from a blowout of a settling pond located on a tributary between the upper and lower Clear Creek study areas. Neither control would have been effected by these effluents because they are both located above the confluence of Clear and Granite creeks. In addition, considerable habitat improvement work continued in upper and lower Clear Creeks in 1983. Coupled with the discharge of mining effluents, it appears 1983 is not a representative post-treatment data point.

Abundance of juvenile steelhead was lower in 1983 than the 1979-81 average in i control areas (Tabies 21 and 22). Consequently, the decrease in steelhead can attributed to any treatment effects.

Juvenile chinook tended to be larger in improved areas of Clear Creek than in G Bull Run creeks (Table 23). Age composition and mean length by age class were similar for steelhead in treated and control areas (Tables 24 and 25).

Six adult chinook were observed in pools that had been constructed for summer h adults. In addition, ten adults were observed in plunge pools behind weirs and observed holding behind a recently placed boulder (John Andrews, USFS, personal communication).

Table 21. Density (fish/100m) of juvenile chinook and steelhead before and aft improvement in Clear Creek.

Year	Upper Clear Creek[a]		Lower Clear Creek	
	Chinook	Steelhead	Chinook	Steelhead
Pre-treatment				
1979	3	105	299	42
1980	0	51	91	35
1981	0[a]	50[a]	107	49
Post-treatment				
1983	16a	50[a]	68[a]	32[a]

a Habitat improvement activities may have influenced densities to some unknow

Table 22. Density (fish/100m) of juvenile chinook and steelhead in Granite and creeks (controls) 1979-83.

Year	Granite Creek		Bull Run Creek	
	Chinook	Steelhead	Chinook	Steelhead
1979	218	108	57	73
1980	56	40	19	60
1981	90	74	76	68
1983	83	24	113	36

Table 23. Mean lengths of age 0 chinook in Clear, Granite, and Bull Run creeks, 1983.

Location	Sampling size	Fork Length (mm)		
		Range	Mean	95% CI
Upper Clear Creek	39	63-94	71	+2
Lower Clear Creek	163	49-94	69	+1
Granite Cr.-control	98	44-90	68	+2
Bull Run Cr.-control.	75	49-85	64	+2

Table 24. Age composition (percentage) of age 1 and older steelhead in Clear, Granite, and Bull Run creeks, 1983.

Age	Upper Clear Creek	Lower Clear Creek	Granite Creek	Bull Run Creek
1	45	40	41	44
2	47	44	52	48
3	8	15	7	6
4	--	--	--	2

Table 25. Mean lengths, by age class, of age 1 and older steelhead in Clear, Granite and Bull Run creeks, 1983.

Sampling Area	Age	Sample size	Fork length (mm)		
			Range	Mean	95% CI
Upper Clear Creek	1	51	89-122	100	+ 3
	2	53	98-163	133	+ 4
	3	9	140-190	164	+ 12
Lower Clear Creek	1	29	81-137	102	+ 5
	2	32	101-161	125	+ 6
	3	11	126-202	168	+ 16
Granite Cr.-control	1	12	83-118	107	+ 6
	2	15	112-176	139	+ 10
	3	2	169-173	--	--
Bull Run Cr.-control	1	21	86-120	97	+ 3
	2	23	91-166	127	+ a
	3	3	144-201	168	+ 74
	4	1	216	--	--

Task 2

Spring chinook redd counts declined 62% and 64% in 1983 from the previous 5 year average in upper and lower Clear Creek, respectively (Table 26). Decreases in spawners were also noted in Granite and Bull Run creeks. The declines reflect a generally lowerspawner escapement in the North Fork John Day River in 1983 compared to previous years (Smith et al. 1983). Eight of thirteen chinook redds in upper and lower Clear Creek wre observed on introduced gravel. Steelhead redd counts in Beaver and Olive Creeks, tributaries to Clear Creek, are shown in Table 27.

Task 3

Measurements of physical characteristics prior to the completion of habitat improvements in Clear Creek were not part of the original study plan in 1979. With the exception of surface areas, which were measured originally, estimates of pre-project conditions will come from data collected by the USFS, Umatilla National Forest. These data will be summarized in 1984.

Table 26. Salmon redds (total) counted in index areas of Clear, Granite, and Bull Run creeks, 1978-83.

Age	Upper Clear Creek	Lower Clear Creek	Granite Creek	Bull Run Creek
1978	4	25	109	31
1979	2	28	86	16
1980	2	28	47	3
1981	2	45	68	7
1982	3	43	66	13
1983	1	12	40	2

Table 27. Steelhead redd counts in Beaver and Olive creeks, tributaries of Clear Creek 1978-83.

Year	Redds/mile	
	Beaver Creek	Olive Creek
1978	1.0	3.5
1979	1.0	2.0
1980	1.5	3.0
1981	2.0	2.0
1982	0	0
1983	0	3.5

Because the controls for the Clear Creek study (Granite and Bull Run creeks) are not in Clear Creek, we did not use them to established physical baseline data as was done for Deer and Camp creeks. Surface area, volume, pool:riffle ratios, cover area, and spawning gravel area are shown in Table 28 for 1983. Expansions of these estimates for the entire project area are given in Table 29.

Task 4

The actual change in smolt production of spring chinook following habitat improvement was calculated by comparing the mean abundance of juveniles in . 1979-81 with that in 1983. Survival rates from juvenile to smolt were obtained from other studies on the John Day River (Lindsay et al. 1981).

Net change in smolt output following habitat improvement in Clear Creek is shown in Table 30. As pointed out in Task 1, 1983 is not indicative of juvenile populations after habitat improvement because of the settling pond blowout and because some habitat work was still being done in Clear Creek in 1983. Nevertheless, data in 1983 do show that there has been no increase in the production of spring chinook smolts in Clear Creek in spite of 4 years of rehabilitation efforts. The data suggest the need to complete instream habitat work as quickly and with as little disruption to the stream as possible.

Table 28. Summary of physical characteristics in treatment and control Stations in Clear, Granite, and Bull Run creeks, 1983.

Location	Surface area (m^2/100 m)	Volume (m^3/100 m)	Pool: riffle ratio	Cover (m^2/100 m)	Spawning gravel (m^2/100 m)
Upper Clear Creek	681	161	57:43	10	88
Lower Clear Creek	939	180	37:63	8	60
Granite Cr.-control	543	98	34:66	7	17
Bull Run Cr.-control	366	59	12:aa	4	0.2

Table 29. Physical characteristics expanded for the entire project area in Clear Creek after habitat improvement.

Characteristic	Post-project
Length (km)	6.4
Surface area (m2)	56,283
Volume (m3)	11,279
Spawning gravel (m2)	4,312
Cover (m2)	547
Pool:riffle ratio	42:58

Table 30. Net change in the number of chinook smolts migrating from Clear Creek following habitat improvement based on data collected in 1979-81 and 1983.

Length of Project (km)	
Upper Clear Creek	1.6
Lower Clear Creek	4.8
Pre-project	
Juveniles/km	
Upper Clear Creek	10
Lower Clear Creek	1,657
Total Juveniles	
Upper Clear Creek	16
Lower Clear Creek	7,954
Post-project	
Juveniles/km	
Upper Clear Creek	160
Lower Clear Creek	680
Total Juveniles	
Upper Clear Creek	256
Lower Clear Creek	3,264
Net change in juveniles	-4,450
Survival, juvenile to smolt[a]	0.25
Net change in smolts	-1,112

[a] From Lindsay et al. (1981).

Task 5

Benefits were not estimated in 1983 because of problems described in Task 4. A general approach fore estimating benefits is given in Task 5 in the results section for Deer Creek. Preliminary cost estimates of habitat improvements in Clear Creek are summarized in Table 31.

Table 31. Preliminary cost estimates for habitat improvement in Clear Creek, 1979-83.

Year	Location	Number	Structure	cost
1979a	Upper Clear Cr.	21	Log weirs	$ 12,600
		5	Spawning gravel beds	3,000
		3	Holding pools	3,000
1981[a]	Upper Clear Creek	17	Log weirs	10,200
		2	Boulders	100
		4	Rock deflectors	1,400
		2	Log deflectors	700
		--	Plugged mine shaft	12,000
1982"	Lower Clear Creek	14	Log weirs	8,400
		60	Boulders	3,000
		1	Rock deflector	350
		2	Log deflectors	700
		40	Spawning gravel beds	24,000
		6	Holding pools	6,000
		--	Mine effluent diversion	1,000
	Upper Clear Creek	25	Spawning gravel beds	15,000
1983[a]	Lower Clear Creek	150	Boulders	7,500
		400	Boulders	20,000
		20	Rock deflectors	7,000
		10	Spawning gravel beds	6,000
	Construction total			$ 141,950
	Maintenance (annual)			3,000
	Total cost (present-worth, discounted @7%)			$ 173,720

a Personal communication, John Andrews, USFS, Umatilla National Forest.

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